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TRANSLATIONS ON USSR SCIENCE AND TECHNOLOGY
BIOMEDICAL AND BEHAVIORAL SCIENCES
(FOUO 5/79)

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ERGONOMICS

PROCESSING VISUAL INFORMATION IN A SITUATION OF ULTIMATE RESPONSIBILITY

Moscow TEKHNIЧЕСКАЯ ЭСТЕТИКА in Russian No 11, 1978 pp 13-16

[Article by Cand Psych Sci V. K. Kalin, Simferopol' State University imeni M. V. Frunze]

[Text] The unique features of visual information processing in a situation of ultimate responsibility have to do with the individual's operational reliability--that is, his capability for stably maintaining optimum working parameters (efficiency, "alertness," "resistance to interference," and so on) for prescribed intervals of time and in the face of possible complications in the situation. Nervous system properties make up one of the most important "human factors" of reliability. (17).

Change in an individual's behavior in extreme conditions, considered in light of his individual features, is quite interesting.

Research has shown (1,4,9,10,13,15,16,21) that extreme conditions can have both a positive and a negative influence on human activity, the differences in goal attainment becoming significant only at a high degree of stress. Among individual characteristics responsible for the resistance subjects exhibit to the action of emotional factors, the strength of the nervous system, as determined by the arousal index, is noted most frequently.

At the same time some investigations (2,8,18-20) have shown that a weak nervous system is important to success in a number of jobs.

It is difficult to compare the data of many researchers because they have been obtained in research on different types of activity and in different conditions. The results of activity depend not only on presence or absence of tension in the subject or differences in the degree to which it is expressed, but also on many other factors (for example the possibility for choice of behavior strategy or correction of actions in the course of their fulfillment, presence of conditions permitting preliminary preparation for the possible development of events, and so on).

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So far the research has centered on macroanalysis of activity using parameters of integrated action as the informative indices--temporal, spatial, and strength parameters (3). But macroanalysis does not allow us to evaluate the work of individual psychophysiological mechanisms.

Study of human activity in a situation of emotional tension from the positions of microanalysis appears promising (3,5-7).

In microstructural analysis of mental activity we isolate the swiftly proceeding components of integrated acts and examine their interaction. Experiments performed on the basis of these methods have revealed a number of functional blocks or levels of information processing, allowing us to subdivide the integrated act of control into its cognitive and controlling components and reveal the ties between the effectiveness with which these functional blocks work and the most general energy characteristics of the brain, and the dependence of these ties on the level of responsibility for the results of the work.

The amplitude dispersion of the background EEG is one of the most general energy characteristics of the brain (it also contains considerable information on individual features). A number of studies have provided information allowing us to interpret this characteristic as an index of the strength of the nervous system (12).

The task of the present investigation boiled down to studying changes, in individual functional blocks participating in visual information processing, which occur in people exhibiting different dispersions of the background EEG in connection with bearing ultimate responsibility for work results.

A technique developed by the department of engineering psychology of Moscow State University was employed. The subjects performed six types of assignments: Reactions to numbers (time spent was recorded) (RT); signal search within a set sequence of numbers (SS); identification of a number stated following presentation of a sequence of numbers (ID); determination of the absent number (AN); total recall of a presented series of numbers (TR); solution of an interfering problem followed by recall of a presented series of numbers (IP), testing corresponding functional blocks (search for numbers on a console; filtration and recoding block; block consisting of initial memory without participation of the recall mechanism; block of elementary logical transformations; response block and initial memory block; repetition block) (7,14).

A special stand was manufactured in conjunction with this technique (11).

The research was conducted on two groups of adult male subjects--experimental (53 persons) and control (30 persons). The subjects were students of the university's physical education department who had frequented the laboratory many times and were well adapted to the experimental situation. Every subject underwent three series of assignments.

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In the first series the subjects in the experimental group were given the following instructions: Work at top speed throughout the entire series, trying to make no mistakes. This series was a unique sort of background for the next two series.

In the second series the subject was instructed to complete the assignment better than in the first series, and he was warned that as soon as he exceeded the total time or total number of errors in the first series recorded after each assignment, he would be subjected to electrocutaneous stimulation. Thus we created a situation of a constant threat of a negative evaluation following every assignment; however, the electric shock was not applied to any of the subjects in this series.

The best time in relation to each assignment in the first and second series was selected by computer (the computer complex simulated a number of counters in the experiment).

In the third series the subjects were told to work better than in the first and second. The subjects were warned that if their times in performing the assignment are worse than their times for the first two series, they would be subjected to electrocutaneous stimulation; the same sort of stimulation would also be applied for every error made.

Thus the subjects were placed in a situation of ultimate responsibility for completion of every assignment.

In reality, however, the subjects were subjected to electrocutaneous stimulation only when they made errors. The warning that they would be punished for too much time helped to achieve a maximum reaction time.

Work with the control group proceeded in the same sequence and in the same volume as in the experimental group. But before each of the three series the subjects of this group were given identical instructions: "Try for the best speed and accuracy." Before the work started, an electroencephalogram was recorded from each subject in a soundproof and shielded chamber, in the dark and following initial dark adaptation at a constant amplification factor, using "10/20" system bipolar C₀-O₂ points of contact and a four-channel encephalograph produced by the L'vov Electronic Medical Apparatus Plant. Electrode resistance was 10-15 kohms. The encephalograph signal was fed to an MN-7M analog computer, which calculated the EEG dispersion and fed a signal to one of the galvanometers of the electroencephalograph. Thus concurrently with the background encephalogram we recorded the dispersion of its amplitude. Then segments having no artifacts were selected in random order from the EEG to represent a total of 60 seconds of brain biopotentials.

The GSR was recorded from the subjects by (Ch. Fere's) method during the entire time of work. The electrodes were secured to the palm and back of the left hand. The recordings were made with an EPP-09 potentiometer, the scale of which was graduated to permit determination of electric resistance of the skin.

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Several mathematical data treatment methods were employed to analyze the results of the experiments: Pearson's correlation coefficient r , the correlation ratio η of the indices of the effectiveness with which test assignments were performed as determined from the dispersion of the background EEG amplitude, and the t -test of significant differences in the results of testing the functional blocks of visual information processing in groups of subjects exhibiting significant differences in EEG amplitude dispersions were computed.

The minimum average current EEG dispersion, represented in millimeters of deflection of the galvanometer stylus, was 0.70, and the maximum was 22.98.

Three groups of subjects were created to permit computation of differences using the t -test: Low EEG amplitude dispersion (nine persons), average (11), and high (11 persons). Differences in the EEG index among these groups were significant at $p < 0.001$.

Examination of Pearson's coefficients of correlation between EEG amplitude dispersions and visual information processing speed and accuracy showed that in the first series of assignments, there is one significant but rather weak positive correlation with the number of errors in the TR assignment ($r = 0.26$, $p < 0.05$).

Application of Student's t -test confirmed the results of correlation analysis: Differences between groups with low and high EEG dispersions turned out to be significant only in relation to the number of errors made in the TR assignment; subjects with the highest dispersion made the largest number of errors ($t = 2.27$, $p < 0.05$).

The same differences in quantity of errors were also revealed between groups of subjects with low and average EEG amplitude dispersions ($t = 2.25$, $p < 0.05$). Moreover there are significant differences between these groups in relation to the total reaction time in the RT assignment ($t = 2.114$, $p < 0.05$), but subjects with the average EEG amplitude had the best time. The latter correlation was confirmed by an examination of correlation ratios between indices of psychometric tests and the EEG amplitude dispersions.

Computation of the correlation ratio measuring the degree of curvilinear and linear correlations revealed a significantly large number of statistically significant correlations between EEG dispersion and the test trial indices in the first series. This implies that most correlations are curvilinear. The results of test assignments involving the work of the most complex blocks participating in visual information processing were found to be dependent on EEG amplitude dispersion. The most stable correlations were revealed between EEG dispersion and the temporal indices of the TR assignment (the response block and the initial memory block are tested) and the IP assignment (the repetition block is tested). In different variants of the quantitative relationships among classes of indices

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examined, the probability of error for the significance of correlation ratios varies from 0.05 to 0.001.

Examination of correlation matrices of curvilinear correlations showed that the scatter of the temporal indices of tests in the neutral situation (from the motivational aspect) was greatest for the group of subjects exhibiting a low EEG dispersion, and it was least for the groups with the average and high dispersions. However, some subjects with a low EEG dispersion do produce good results.

In the second series of test trials involving the threat of electrocutaneous stimulation, it was established on the basis of the coefficients of correlation analysis and the *t*-test of significant differences that subjects with a low EEG amplitude dispersion had better qualitative indices (at $p < 0.05$) in the SS assignment (testing the filtration and recoding block) and the ID assignment (testing the initial memory block less the recall mechanism). The worst qualitative results were typical of subjects with an average EEG amplitude dispersion in relation to the SS assignment, and subjects with the high dispersion in relation to the ID assignment. Statistically significant correlations were not revealed between the other indices.

Examination of changes in the GSR during the work showed that many of the subjects developed tension immediately after receiving the instructions, though as a rule it passed quickly (the GSR value returned to its initial level).

Thus tension did not persist throughout the entire second series. Nevertheless significant correlations between EEG amplitude dispersions and indices describing performance in the most complex assignments (TR and IP) disappeared, and correlations arose with qualitative indices of the easier assignments--SS (performed at the level of sensory traces and being independent of the sensory memory block) and ID, which requires engagement of the initial memory block less the recall mechanism.

In the third series of test assignments, in which the subjects worked in conditions imposing real responsibility for the results of each trial, the direction of correlations between the indices of the psychometric tests and the EEG amplitude dispersions changed for the opposite in most cases in comparison with the first two series, becoming linear.

Out of the Pearson correlation coefficients computed on the basis of the work results of the entire group of subjects, only two were found to be statistically significant; these were negative correlations between EEG dispersion and SS latent time-- $r = -0.275$ ($p < 0.05$), and between the electroencephalographic index and the number of errors in the ID test-- $r = -0.305$ ($p < 0.025$). These data indicate that when these assignments are performed in the critical situation, subjects with a low EEG amplitude dispersion begin to work much more poorly than subjects with a high EEG dispersion.

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GSR recordings made during the third series show that the tension exhibited by subjects varied in the situation of real punishment for errors. Four groups of subjects could be distinguished: A--18 persons, whose tension remained high from the beginning to the end; B--18 persons whose tension was significant at the beginning of the series and noticeably declined toward the end (in a number of cases the GSR value returned to its initial level); C--10 persons exhibiting almost no changes in the GSR; D--7 persons with an average GSR.

Analyzing the research materials, we computed both the absolute indices of work effectiveness in the different test assignments, and percent changes occurring in these indices from series to series.

Among coefficients illustrating the level of correlation between EEG dispersion and the absolute indices of test trials in the third series, only one was found to be significant--the correlation with errors in assignment IP ($r=-0.418$, $p<0.05$). This correlation was discovered in group A.

Analysis of the correlations of EEG dispersion with changes in the indices of the psychometric tests revealed many more significant correlations. The results of the analysis, which was performed in relation to three groups of subjects--the first consisting of subjects from all groups, the second consisting of subjects from groups A and B, and the third consisting of subjects from group A--are shown in the table below.

We can see from the table that all correlation coefficients are positive. This says that subjects with a higher background EEG amplitude dispersion exhibit large changes in the direction of improving speed and accuracy in a number of test assignments, both in a threat situation and in the situation of real punishment for every error; in a significant number of the cases subjects with a low EEG dispersion, meanwhile, exhibit a worsening of their indices in the examined situations.

We should also turn our attention to the fact that most of the correlations revealed have to do with the most complex assignments--TR and IP. In relation to the IP test, EEG amplitude dispersion was found to be correlated not only with temporal parameters but also with the qualitative index (number of errors). In this case the strongest correlation is revealed in groups exhibiting pronounced tension during the third series.

In relation to the rest of the assignments, correlations were revealed only with the temporal indices of the test trials. Subjects with a low EEG amplitude dispersion could achieve their previous qualitative indices only by worsening their temporal indices, while subjects with a high EEG dispersion managed to maintain qualitative indices and significantly increase their speed in the assignment in the critical situation.

Correlations were not revealed in relation to the RT and AN assignments.

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Coefficients of Correlation Between EEG
Amplitude Dispersion and Changes Occurring in Psychometric
Test Indices from Series to Series

Assign- ment	Indices	Coefficients for Group 1			Coefficients for Group 2			Coefficients for Group 3	
		2/1	3/1	3/2	2/1	3/1	3/2	3/1	3/2
SS	a	--	262*	259*	--	--	307*	--	--
ID	a	--	302**	246*	--	--	--	--	--
TR	a	--	--	--	320*	319*	--	--	--
	b	--	249*	--	298*	308*	--	--	--
IP	a	237*	302**	--	298*	384**	--	485**	--
	b	--	255*	--	--	365**	--	--	--
	c	--	268*	--	--	366**	--	586***	512**

Notes:

1. Only correlation coefficients significant at $p < 0.05$ (*), $p < 0.01$ (**), and $p < 0.001$ (***) are shown.
2. Column symbols: 2/1--% ratio of second series to first; 3/1--% ratio of third series to first; 3/2--% ratio of third series to second.
3. Indices: a--latent time, b--total reaction time, c--number of errors.

The RT assignment is sufficiently simple; errors made during it stem not from erroneous perception of numbers but rather from accidental pressing of neighboring keys.

At the same time absence of significant changes in the speed of the simple reaction to a presented number (RT) implies that on the whole the tone of the central nervous system does not experience significant changes in this experimental situation, and the influence of the latter on the state of certain functional blocks is to a certain extent selective.

Absence of significant correlation between EEG amplitude dispersion and changes in the indices for the AN assignment in the situation of ultimate responsibility for work results implies that operation of the block responsible for elementary logical transformations and playing an important role in the AN test is not associated with the examined characteristic of the background EEG.

In the threat situation and the situation of ultimate responsibility, the most significant changes occur in the response, initial memory, and repetition blocks (assignments TR and IP). Our research revealed a clearly pronounced tendency toward better work of these blocks in subjects with a high EEG amplitude dispersion, and toward worse work in subjects with a low EEG dispersion.

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Examination of the correlation matrices would show that the scatter of indices describing changes in the results of the test trials from one series to another (and the absolute values) are greatest for the group of subjects with a low EEG dispersion. Certain subjects of this group managed to demonstrate significant improvement in the results of their work in the third series (no less than the improvement shown by subjects with the high EEG dispersion).

Comparison of the results of test assignments performed by subjects working in situations of ultimate responsibility with indices of the control group using Student's *t*-test showed that the most significant improvement occurred in group C in relation to assignments SS ($p < 0.01$), ID ($p < 0.01$), and AN ($p < 0.05$). In comparison with the control group, the greatest deterioration of results in the third series occurred in groups exhibiting a pronounced emotional reaction (groups A and B)--in the latent time of RT ($p < 0.05$) and the quantity of errors in the IP test ($p < 0.05$). Subjects with a low EEG dispersion were mainly responsible for this deterioration.

Not very many statistically significant differences were found between the experimental groups and the control group. The reason for this lies in the fact that individual features significantly mask group differences. Thus in the situation of ultimate responsibility some subjects exhibited improvement of indices in the psychometric tests (some experienced improvement in all 16 indices of the test assignments in this situation), while others exhibited a worsening of indices (some subjects did worse in relation to 10-11 indices out of 16).

Thus the research showed that the individual features of the subjects pertaining to the speed and accuracy of visual information processing in the situation of ultimate responsibility are significantly correlated with the dispersion of the amplitudes of their background electroencephalograms (the nervous system strength parameter), but at the same time it becomes obvious that nervous system strength (as determined from EEG dispersion indices) is not the sole determinant of successful work. The influence of other determinants must be clarified.

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GENETICS

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LONG-RANGE DIRECTIONS OF GENE ENGINEERING

Kiev MOLEKULYARNAYA BIOLOGIYA in Russian No 19, 1978 pp 3-10

[Article by V. A. Kordyum, Institute of Molecular Biology and Genetics, Ukrainian Academy of Sciences, submitted 13 Jan 77]

[Text] Numerous popular publications about gene engineering have generated the most diverse conceptions of this direction of biology. At the present time, we see a striking contraction between what is expected of gene engineering and the fact that not a single practical problem has been resolved in this field. Such a situation requires comprehensive analysis. With reference to long-range aspects, let us first define what this should mean. We shall use the term "long-range directions" to determine what could actually be achieved for the practical activities of society. We shall limit the time of expected results to the next five years in this analysis.

Historically, the "birth" of gene engineering can be dated to 1928, when Griffith discovered the transformation phenomenon. However, this direction actually became a reality only in 1972, when Berg joined the genome of λ phage and SV-40 virus, after which it was demonstrated that controlled fragmentation of DNA and formation of recombinant molecules is possible with the use of a second class of restrictases that form sticky ends and DNA ligases. From that time on, the technique became feasible in any laboratory with a certain modicum of instruments and reagents. Only 5 years have gone by, and already the most diverse organisms, at all steps of the evolutionary ladder, have become the objects of gene engineering research: microorganisms, plants, animals and man.

Most of the methodological studies have been made among the prokaryotes. At the present time, one can obtain virtually any group of genes, at any rate in the class of bacteria or viruses, introduce it into phages, plasmids, etc. There is intensive deployment of gene engineering work with eukaryotes. One could expect that a wide enough range of genetic material will lead, if not to a revolution in the national economy, at least to rapid development of producers for the microbiological industry. However, nothing of this sort has happened as yet. This is attributable to the fact that if there is a source for a given gene or group of genes (for example, responsible for the

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formation of some fragment or other), this source (i.e., the actual producer) by itself can provide for biosynthesis of the required product, provided the appropriate technology is available. There is no practical purpose in transferring some genes from one producer to another, while it has not yet been possible to obtain complete expression of genetic information moved from a eukaryote to prokaryote systems. In only one unconfirmed work, that of Davis from Stanford University (United States), is it reported that there was expression of the histidine operon of yeast in a bacterial cell. Other research in this direction indicates that there are substantial disturbances in this process. It was found more expedient to assemble several characters together, forming an organism with a fuller set of the required properties. We already have examples of such work. However, the attitude toward this direction, which is part of applied ecology, is quite reserved. In the first place, it is not yet clear how the new gene engineering product will behave under real, rather than laboratory, conditions; in the second place, the development and release into the environment of an organism [individual] with complex properties that did not exist before constitute an overt infraction of the existing international agreement.

Thus there are no conceptions in genetic engineering that would permit using the developed methods and obtained results for immediate solutions of specific practical problems. For this reason, our first task was to create such a conception. It was developed, related to various groups of objects--bacteria, plants, animals, man--and consists of the following.

As related to bacteria, there are two possible approaches, depending on the product one wants to obtain. With some arbitrariness, one can divide all products of metabolism into two groups, primary and secondary. Primary ones are directly linked with genetic information. These are the products of template synthesis (replication, transcription and translation), i.e., DNA, RNA and proteins. Secondary metabolites are the products of enzymatic activity of the cell. From the standpoint of modern gene engineering, the focal problem is to transfer information and express it as a functionally active protein, i.e., production of primary metabolites. For this reason all primary metabolites are equivalent in the first approximation. The situation is quite different with production of secondary metabolites. A single enzyme is involved in forming some products and an entire set of enzymes in forming others; the function of the latter is strictly coordinated, both in space and in time. In turn, some enzymes play a key role and others, a dependent one in such cycles, which are often quite complex. Although anabolic and catabolic processes in the cell consist of more or less complex cycles (which are interrelated also), from the practical point of view, catabolic enzymes are usually of independent significance, for example, some proteases, cellulase, β -galactosidases, etc. Anabolic enzymes are more often required in the form of a complete set to run the entire cycle, since the end products (amino acids, vitamins, etc.) are needed. This must be taken into consideration when planning gene engineering studies.

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We propose the use of the supersynthesis phenomenon, controlled by temperate phages, for commercial production of primary products and, first of all, enzymes. It should be noted that the procedure, which could be made universal, directs the process in such a way that the yield of product with which we are concerned under technologically suitable conditions becomes commensurate with all the other cell metabolites together.

We could expect that, by virtue of the supersynthesis phenomenon, even in the next few years, it will be possible to augment appreciably the yield of many products that are being produced and prepared for production by industrial microbiology. The efforts at supersynthesis, undertaken before ours, using information transferred to small plasmids turned out to be nontechnological and, as a result, unsuitable for practical purposes, while expression of genes introduced by phages was no greater than in mutant forms of the corresponding bacteria. In assessing the potential of supersynthesis, it must be borne in mind that transfer of a character determined by expression of one gene by means of temperate phages is the simplest task, as well as the one that can be fulfilled the fastest. It will be somewhat more difficult to transfer a character implemented by the function of one enzyme, but consisting of different subunits. Some complications may arise as a result of the fact that all cistrons coding the subunits of a given protein should be assembled in one operon (for example, the protein of RNA polymerase consists of four subunits coded by four structural genes situated in three segments of the chromosome), or else be a natural part thereof. The larger the DNA fragment, the more difficult it is to obtain it under controlled conditions. Finally, the polypeptides formed in the recipient cell must be correctly assembled. Nevertheless, all this appears to be quite feasible. The main difficulty will be that, in spite of the quite extensive studies pursued in different institutions, among the numerous fragments obtained and described there are virtually none that would carry information for synthesis of industrially important enzymes. An intensive search is now in progress in this field. For the time being, the potential of supersynthesis of added information to anabolic processes is unclear. For this reason, a different route is proposed for them, in which the multiplicity of genomes is not introduced exogenously, but is created and constantly present in the cell.

With reference to the consequences of transferring information to an independent and complete anabolic cycle, for example synthesis of sugar or amino acid, a special situation arises. In this case, there must be simultaneous formation of several (and, usually, many) enzymes. Each of them must be properly assembled, and all of them together should implement a strictly coordinated successive process. This involves a new stage of organization, which is related to appropriate arrangement of newly formed proteins on cell structures, among the many macromolecules already present. It can be expected, a priori, that with increase in number of genes such a system will function well only in a homologous or similar recipient. It is unlikely that such complex systems will function with any significant efficiency under markedly heterologous conditions, this would require some other transformations that are not quite clear as yet. For this reason, it is best to

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augment the number of copies existing in gene cells. In the bacterial cell, structural genes are represented by one specimen, and all the scheming of genetics of industrial microorganisms are directed toward more productive expression thereof. Some rather impressive results have been obtained in this area. However, systems with several identical genes can be created with the existing techniques. For example, using a set of phages of the lambdoid type with different integration sites but the same transducing marker, one can obtain a cell with several genes in addition to the existing one, which are inserted in different parts of the bacterial chromosome (the opposite of the Shimada method). Of course, one can increase the number of copies of a single industrially valuable gene in the very same manner. Such an operation would apparently improve substantially the national economic indices of the producer. Technically, it is already feasible today.

The question may arise as to whether increasing the number of copies of information in the bacterial chromosome would lead to growth of overall productivity of a specific metabolite. For we know that, in the case of polyploidy of higher organisms, there is not an adequate amount of gene copies and products of their expression. However, in the case of polyploidy, we are dealing with alleles and, starting with the diploid set of chromosomes, there are evolutionarily developed mechanisms of homologous discrimination. But in those cases when the number of copies is increased in a haploid set of chromosomes (tRNA, rRNA and histone genes), their expression under conditions of total derepression is consistent with the volume of information in eukaryotes as well. In such a case, the increased amount of copies in bacteria would also be present in the haploid chromosome. For this reason, we can expect that there would be an adequate increase in productivity, provided a proper choice is made of technological management of the process.

Thus, in view of the fact that the microbiological industry is the most obvious and immediate area of application of gene engineering, it can be considered that studies dealing with transfer of information for synthesis will be the most promising, in each specific case for one enzyme important to the national economy, or a complete anabolic cycle, in order to develop producers with several copies of the information of interest to us, or production of recombinant temperate phages to implement subsequent supersynthesis.

On the basis of the work that has been done on supersynthesis of β -galactosidase, the use of gene engineering techniques will make it possible to augment by many times (at least a factor of 10) the productivity per unit of reactor working volume in the microbiological industry. This will lead to wide use of enzymes in industry, agriculture and medicine, the results of which would be difficult to evaluate at the present time.

In addition to the microbiological industry, gene engineering manipulations with bacterial may also be promising in other fields. Applied ecology is an interesting direction, in which the first practical success has been achieved. But, at the same time, this is the most debatable area of

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application of the technology for selective transfer of information, since forms known to be capable of existing outside the laboratory and carrying new sets of characters can be created. This situation appears to be rather risky. However, in applied ecology there is a direction involving no risk, but with unquestionable advantages. We refer to nitrogen fixing. There are some special reports dealing with it in this collection.

Higher plants constitute the next group of objects for gene engineering. However, although it would seem that information transformation thereof is desirable, the very first analysis shows that things are not so simple. Indeed, plants do not require additional catabolic processes, at any rate those that are accessible to transfer. As for anabolic cycles, they are complex, shifting of information for implementation thereof (for example, to increase the number of gene copies) from plant to plant is still methodologically unfeasible, whereas it would hardly be productive with regard to bacteria (or phages) for the reasons discussed above (heterologous state of systems). For this reason, research that is unquestionably interesting on the scientific level would be impossible on the level of practical applications in the next few years. The situation may be different with respect to other transfers. For example, it appears to be realistic to transfer to plants information for the synthesis of the enzyme nitrogenase (which implements nitrogen fixing). We can expect success with anabolic cycles, with regard to the transfer of a gene (or genes) that codes only one key enzyme, rather than all enzymes in the process, according to which regulation occurs. We could expect that the bacterial gene will be found insensitive in the plant cell to regulation of the repression type, while by using appropriate mutants as donors we could avoid regulation by retroinhibition and thus induce stimulation of the entire process by overcoming the "weak point." But methodologically the routes for such transformation have not yet been developed.

Use of information for "detracting" proteins of the neutral type appears to be quite promising. If a template is inserted in the cell to code polymerization of one amino acid, a given homopolymer will be formed. Thus, it was demonstrated that if a polysequence is inserted in tobacco mosaic virus, polylysine will appear in the stricken plant. However, not all such homopolymers are harmless to the cell. Thus, polylysine, which is a polymer of the base amino acid, forms a polypeptide with strong base properties, superior to those of histones. Insertion of excessive histones in the cell induces severe impairment of intracellular processes, which lead to retarded growth or even death of the cell. We can expect different results with the formation of neutral polypeptides. Their appearance will not lead to metabolic disturbances, but will detract a specific amino acid. As a result, there should be more intensive synthesis of this deficient amino acid, with accumulation of the excess in the form of the corresponding polymer. There is no information in nature for such synthesis. But it can be obtained artificially. Such a task is quite feasible at the present time. Imparting the capacity to inhibit a given metabolic cycle may be an interesting direction of plant gene engineering. For this, it would be enough to transfer information for synthesis of the corresponding

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inhibitor protein. As a result, it will be difficult for a specific key reaction to occur, and there will be accumulation of the precursor product. For example, prevention of polymerization of sugar into starch would provide for prolonged preservation of sweet corn in an industrially valuable condition without additional technical devices. Inadequate development of the relevant branches of plant biochemistry and molecular biology is the obstacle to such work. It is also interesting to consider the possibility of imparting some adaptive processes of a constitutive nature. For this purpose, a specific gene or group of genes could be supplied with an autonomous promoter. As a result of such an operation, the genetic information would cease to be governed by regulatory commands and would be expressed at a rather constant rate. In practice, development of an individual promoter and joining it with any DNA fragments, either at the sticky ends or end-to-end, has already been done, and the main deterrent to such work is the lack of information about organization of the plant genome and its controlled fragmentation, separation and functional identification of fragments. Incidentally, after answering these questions, it will be possible to undertake the task of increasing the number of copies of specified genes that function in an adaptive or constructive mode (when united with their own promoter). Perhaps the greatest difficulty in this case is to find the basic route of functional identification of DNA fragments of higher plants. Two methods are being developed to solve this problem. The first consists of transformation of plants. We have demonstrated, together with the department of experimental mutagenesis, that this is feasible in theory. The exceptionally wide set of diverse corn mutants provides good opportunities for subsequent demonstration of many markers in DNA fragments. The second method is based on creating a special vector for higher plants on the basis of the large T1 plasmid of *Agrobacterium tumefaciens*, which induces crown galls. Bacterial plasmids are excellent vectors, and they are used extensively in genetic engineering to insert information in the bacterial system. For this reason, there is every reason to expect that the T1 plasmid, which has teratogenic properties, will turn out to be an exceptionally good object in plant gene engineering, although there are still some problems to be resolved, which are related to its high molecular weight. Such studies are developing intensively. The main advantage of a teratogenic vector is that even a single act of recombination in the genome of a somatic cell leads to formation of proliferation that is readily demonstrable and analyzed. Such a vector could be used to solve many problems of plant gene engineering.

We can expect that the bulk of the preparatory work related to creating vectors for plants, identification of genes in DNA fragments and obtaining recombinant vector-functional molecules carrying specified information will be done in the current 5-year period. Most likely, deployment of work dealing with direct information-related transformation of cultivars will begin in the next 5-year period.

Probably the most difficult and least developed problem is that of gene engineering work with animals. Actually, there have been more than enough

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proposals and desires in this field. However, such proposals and wishes are still without a real scientific and methodological foundation. The only real possibility thus far is a procedure related to bacterial substitution. This is a well-known procedure of medical microbiology which acquires utterly new implications, in our opinion, in connection with the capabilities of gene engineering. In essence, microbial substitution refers to the following: The existing methods of bacterial therapy, which originate with I. I. Mechnikov, imply for the substitution (usually, partial and temporary) or normal (or pathological) microflora of man and animals with bacteria having certain useful properties. It is usually the intestinal microflora that is replaced. In this regard, an interesting example is the transfer into the animal intestine of representatives of normal microflora with the *nif* operon, which has minimal sensitivity to repression by bound nitrogen. If such a *nif* operon (and the bacteria with it, but which normally do not contain it, have already been obtained) is transferred to bacterial strains that prevail in farm animals (with consideration not only of species, but breed, as well as geographic region), we could expect that after inserting it the animal will be able to provide, to some extent, bound nitrogen for itself. As an example, let us indicate that the intestinal microflora of a cow weighs 4 kg. Active nitrogen-fixing of 25% of it would be more than sufficient for the animal. The principle of bacterial substitution may turn out to be a rather promising one, capable of solving problems that are insoluble at present. For example, it is not possible as yet to obtain nitrogen-fixing cows. At the same time, development of animals that can partially meet the bound nitrogen requirements by means of nitrogen-fixing intestinal microflora is a very real problem. We must discuss here the question of safety, for after all we are dealing with development of an organism that is not only capable, but intended for existence outside the laboratory. However, the property imparted to it is widespread in nature, and one could hardly conceive, even theoretically, of any undesirable consequences of such a procedure.

At the present time, transfer to animals of information for the enzyme cellulase, which is capable of digesting cellular tissue, is another direction in which work could already begin. In the case of a successful solution, an animal will appear with a sharply broadened feed base and better assimilation of feed. But some substantial difficulties will arise, which are related to the fact that, in addition to actual transfer of information for this enzyme, it will be necessary to have it appear exclusively (or at least mainly) in glandular cells of the intestine with mandatory excretion in the intestinal cavity. This is a rather complex matter and the methodology has not yet been found. Everything indicates that things would be considerably simpler for bacterial substitution. Transfer to an additional class of intestinal bacteria of animals of the capacity to synthesize cellulase and migration thereof from cells would lead to such a result, and feasibility is not only a reality, but referable to the next 5-7 years.

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Finally, there remain problems of gene engineering as they relate to man. With the very formulation of this aspect, so many moral and ethical problems, as well as all sorts of apprehensions arise, that the subject is more than complex. But, since nothing gets solved by itself, here too rational analysis is required. Perhaps the consequences of experiments dealing with microbial substitution can be estimated the best. Such procedures in man are officially allowed in strict medical regulations (for example, in the presence of dysbacteriosis). Here is one of the examples of a possible gene engineering procedure involving substitution: It is known that a considerable number of people does not assimilate dairy products due to presence of lactose. Breakdown thereof into monosaccharide is induced by the enzyme β -galactosidase. At the same time, there is a real possibility of using special strains to replace the *E. coli* microflora that produces significant quantities of β -galactosidase excreted in the environment. Such a substitution would have only a temporary effect but, we believe, considerably longer than that of a pure enzyme preparation. The probability of potential hazard of this procedure is nil, since experimenters have encountered strains suitable for such work for many years, long before work in gene engineering began, without adhering to any special rules (other than the usual laboratory ones). It can be stated with certainty that, for at least the last 20 years, people and their surroundings have been in extensive contact with such forms, and nevertheless there has never been even a suggestion of any adverse consequences. Along with knowledge of the corresponding genetic information implementing synthesis of β -galactosidase, it can be stated that such a substitution would be completely safe, while animal experiments can already be begun, since the required strains and techniques are available. Of course, this principle could also be applied to therapy of a number of other hereditary diseases.

Gene insertions constitute a more complex form of intervention in man. This topic was discussed rather extensively in the literature with reference to treatment of monogenic hereditary diseases. However, utterly different directions are possible. For example, there would be a real possibility of gene engineering therapy of drug addiction. Insertion of genes responsible for formation of an enzyme that decomposes a given drug from a microorganisms would result in loss of susceptibility of the macroorganism to it. Such an insertion could be made of the adaptive or constitutive type, which would lead to constant presence in the body of the appropriate "guard" enzyme. It would be best in the case of an enzyme that breaks down only the drug, for example, heroin, and does not affect normal cell metabolites. In the case of complex action (for example, alcohol dehydrogenase), the adaptive form of gene expression of inserted information may be best. Then, rapid regulation of the prokaryote type would provide for inclusion of a structural gene (or genes) and lead to virtually immediate appearance of the necessary enzyme after intake of the drug. Such work could already begin now, with regard to methodological readiness.

Another nonstandard field could be gene engineering gerontology. Accumulation of waste, the "dead end" metabolic products that cannot be or are

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difficult to eliminate, is one of the causes of deterioration of human cell and tissue functions with age. Cholesterol and lipofuscin are well-known examples. Transfer into the human cell (at birth or starting at a certain age) of genetic information from microorganisms with the proper enzymes of degradation of these metabolites would lead to their constant elimination from the body as they are formed, and this could have a beneficial effect on metabolism. Such work should start with isolation of specified genes, and they could be started at any time.

With reference to long-term plans, we inevitably are faced with the attempt to evaluate actual target dates of practical fulfillment. This consists of basic feasibility and difficulty thereof. For this reason, even when all processes leading to the desired result have already been described, obtaining the actual result would require a certain time, the extent of which would depend on many elements. Still, it can be expected that, already in the current 5-year period, i.e., before the end of 1980, many specific problems will be resolved. In the area of industrial microbiology, there will apparently be a drastic increase in enzyme production for industry, agriculture and medicine, as well as, perhaps, production of secondary metabolites (for example, amino acids). This will happen on the basis of development of special extrachromosomal determinants of super-synthesis, as well as producers with an enlarged set of specific genes. There will be continued development of applied ecology on the basis of gene engineering manipulations with microorganisms. Basic solutions will be found for controlled addition of specified information in plant objects. As for the practical results, it is unlikely that some will be obtained for plants under the current 5-year plan.

With respect to man and animals, we can expect that derivatives of normal microflora (mainly *E. coli*) will be obtained and tested for bacterial substitution. Direct intervention is unlikely to go beyond the framework of obtaining specific genes and group of genes, development of methods of controlled insertion and ironing out the moral and ethical principles and safety rules, which is a mandatory element of such applied studies.

Thus, under the current 5-year plan, the practical use of the first gene engineering systems and basic research on fundamental aspects of the next stage, direct information-related transformation of eukaryotes, will begin. Actual direct transformation of higher organisms on a wide scale will begin under the next 5-year plan.

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PUBLICATIONS

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STUDIES IN CHILD BRAIN DEVELOPMENT

Leningrad RAZVITIYE FUNKTSIY MOZGA REBENKA (Development of the Functions of the Child's Brain) in Russian 1978 signed to press 14 Jun 78 pp 2, 3-6, 118-126, 127.

/Annotation, introduction, bibliography and table of contents from book by T. P. Khrizman, Nauka, 2,150 copies, 127 pages/

/Text/ Annotation

This monograph is devoted to the study of the spatial organization of electric brain processes and its functional importance at various stages of development. A close connection among the rise in the level of processes of spatial synchronization of the biopotentials of projection and association brain sections, change in the frequency spectrum of crosscorrelograms, increase in the power of periodic components and change in the phase relations of biopotentials in children during the perception of simple and complex sensory signals and during the perception and identification of a word and various verbal commands was disclosed. 248 bibliographic entries; 39 illustrations; 8 tables.

Introduction

Neurophysiology has now entered an important stage in its development, when man, his brain and the most complex forms of psychic activity--speech, thinking, memory, various types of voluntary movements and so forth--have become the subject of careful electrophysiological investigations.

Such an opportunity has appeared only owing to the penetration of computer technology and mathematical methods into neurophysiological experiments and medical diagnosis. The study of the continuous wave activity of the human brain (EEG), of the dynamics of slow electric processes, of the nature of neuronal impulse activity, of the characteristics of regional blood flow and of the changes in evoked activity to various sensory effects made it possible to embark on a very fine analysis of the neurophysiological mechanisms of the structural-functional and neurophysiological basis of man's psychic activity (Bekhtereva, 1971, 1974; Bekhtereva, Bundzen, 1974, 1977). All this fundamental research is conducted mainly under clinical conditions in stereotactic operations and deep brain structures are largely subjected to

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a detailed analysis. With regard to the central neurophysiological mechanisms of organization of the most complex psychic functions at the level of the whole brain and the role of association sections of the neocortex in the regulation of these system processes in the healthy person and, especially, in children, these problems in brain physiology as yet have been studied very insufficiently.

According to the modern theory of localization of psychic processes, the whole brain is involved in the performance of psychic functions in man, but each brain section makes its differentiated contribution to its general work (Luriya, 1963, 1970, 1973). Association sections of the neocortex--frontal and subparietal zones, which are closely connected with the regulation of man's integral behavior through the speech system--hold a special place among the various brain structures related to complex psychic processes. The involvement of these complex brain formations in the performance of many higher cortical functions, that is, in the organization of purposeful movements and actions, complex intellectual operations and higher gnostic processes, in the programming of constructive activity and the organization of a speech utterance scheme and in the organization of visual spatial and symbolic (quasispacial) syntheses and speech memory processes, can be considered proven by numerous clinical observations and neuropsychological investigations (see the following surveys: Luriya, 1970, 1973; Khomskaya, 1972; Batuyev, 1973; Traugott et al., 1973).

It becomes obvious that, without taking into consideration the regulating role of association sections of the brain in the organization of complex forms of child behavior, in general, it is difficult to understand how the child's complex psychic processes, such as speech, thinking, memory and voluntary actions, develop and are regulated.

Investigations of the regulating role of association zones in children's behavior are of special current interest if the fundamentally important principles developed by Soviet psychologists to the effect that all psychic functions are formed in the child only in the process of practical activity are taken into consideration. The child, in his constant communication with adults reorganizing his behavior on the basis of object activity and speech and assimilating specific knowledge, acquires not only new forms of attitude toward the external world, but also develops new types of regulation of his behavior and forms new functional systems enabling him to master new forms of perception and memory, new types of thinking and new methods of organization of voluntary movements (Vygotskiy, 1960; Zaporozhets, 1960; Lyublinskaya, 1965; Venger, 1969; Leont'yev, 1972; Leushina, 1972; Pod'yakov, 1977). In fact, L. S. Vygotskiy (1960) pointed out the great importance of association brain sections of "higher" centers in the development of the child's psychic functions. Studying the relationship between elementary and complex psychic processes in children at various stages of development, he expressed the assumption that higher psychic functions formed on the basis of elementary psychic processes begin to affect their basis, reorganizing the child's elementary activity. L. S. Vygotskiy further noted that the functional relationship among individual cortical zones changes in the process of development.

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Whereas at the first stages of ontogenesis the formation of "higher" centers depends on the maturity of "lower" centers, in the child's formed behavior "higher" centers organize the work of "lower" centers and subordinate them to their effect. These important assumptions on the change in intercentral relations in the child at successive stages of ontogenesis open up new prospects for understanding the functional importance of intercentral interactions of cortical projection and association sections and the special role of association areas as "higher" centers in the regulation of these interactions at the later stages of ontogenesis.

It can be assumed from the above stated that the investigation of association sections of the neocortex and their role in the development and refinement of the child's higher psychic functions is one of the important trends in the physiology of the human brain. What are the general theoretical premises confirming the urgency and theoretical importance of this problem?

It is well known that the fundamentally important stage in the complication of cortical integrative mechanisms is connected with the appearance and development in the course of progressive evolution of the mammals of association areas, in which, in the absence of a dominant representation of any one sensory system, a wide convergence of signals of a varying modality takes place. An increase in the size of the neocortex at the higher levels of phylogenesis occurs as a result of the expansion of the territory of association areas. The most intensive growth of association areas is observed in the primates. In man they comprise approximately 50% of the whole neocortex (Polyakov, 1949, 1962) and, according to recent data, 84% of the area of the whole cortex (Campbell, 1965).

Fundamental research by physiologists and clinicians (Bekhterev, 1907; Pavlov, 1949; Shustin, 1959; Shumilina, 1966; Anokhin, 1968; Batuyev, 1968, 1971, 1973; Lagutina, 1972; Pribram, 1975) and morphologists (Kononova, 1949, 1972; Polyakov, 1949, 1965; Stankevich, 1961, 1965; Adrianov et al., 1973; Adrianov, 1976), as well as numerous electrophysiological studies (see the following surveys: Batuyev et al., 1973; Polyakova, 1977), showed that association systems have a complex constitution and numerous connections with various subcortical structures, including nonspecific and association nuclei of the thalamus, and are involved in the regulation of diverse functions, that is, from the integration of situational and triggering afferentation, creation of afferent syntheses, organization of a program of action and so forth to the evaluation of the result of action and regulation of emotional states and memory processes. With regard to ontogenetic investigations of the development of concrete physiological mechanisms enabling association regions to perform these numerous functions, they are almost absent.

There is also a considerable lack of correspondence between specific morphological data on the structural characteristics of association areas in children in ontogenesis and on the functional evolution of these sections of the neocortex and the formation of their functional multivaluedness. By this

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time morphologists and histologists have studied in sufficient detail the structural development of projection and association areas in man in ontogenesis and have shown their nonuniform formation (Kononova, 1949, 1962; Polyakov, 1949, 1962; Stankevich, 1961, 1965; Blinkov, Glezer, 1964; Kuku-yev, 1968). For example, according to the data by S. M. Blinkov and I. I. Glezer (1964), the surface of the cortex of the newest regions--frontal and subparietal--increases ninefold, whereas the surface of occipital, precentral and postcentral regions increases only fivefold, and that of limbic and insular regions, only twofold or threefold.

Such a nonuniform development is undoubtedly connected with the functional nonequivalence of these cortical zones and with the different rates of their development. One thing is clear: Association areas directly related to the organization of higher cortical functions (speech, gnosis, praxis) increase in the process of ontogenesis to a much greater extent than the nuclear zones of analyzers. Fundamental questions arise: Why do the association formations of the neocortex sharply differ in the rate of development and degree of increase in the surface of the cortex from projection zones? What is the functional meaning of this for the development and refinement of higher cortical functions? At what stages of ontogenesis do association zones begin to function, that is, make--even if elementary--intersensory analysis and synthesis constituting the basis for the formation of numerous associations? These questions have hardly been studied, but they are extremely important for understanding the integrative activity of the child's brain.

Since cortical association fields, or zones overlapping analyzers, are closely connected with the activity of various sensory systems, their development can be considered only in interaction with other sections of the child's brain.

In this respect the study of the electric processes of projection and association structures of the brain and clarification of the statistical connections of fluctuations in biopotentials at various stages of ontogenesis are also very promising. If we proceed from the modern concepts of the principles of organization of intercentral interactions at the level of neuronal ensembles developed by prominent electrophysiologists and morphologists (Livanov, 1972; Kogan, 1963, 1970; Burns, 1969; Bekhtereva, 1971, 1974; Sologub, 1973; Adrianov, 1976; John, 1977), it can be assumed that the rhythms of the child's brain and their space-time organization reflect the dynamics of intercentral interactions of various cortical regions concerned with the child's concrete activity. This work is devoted to the study of this problem.

Having used the method of crosscorrelation analysis of EEG, as long ago as 1963 we first disclosed the characteristics of space-time organization of brain biopotentials in children aged 7 to 14 during the performance of voluntary movements. This material was correlated in the monograph "Dvizheniye Rebenka i Elektricheskaya Aktivnost' Mozga" /The Child's Movement and Electric Activity of the Brain/. Subsequently, the front of our research on the functional development of association sections of the neocortex was expanded considerably.

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This work set the following tasks:

- 1) To study the characteristics of space-time organization of the biopotentials of projection and association brain sections in children from the first months of life until the age of 7 in a state of calm wakefulness.
- 2) To show by the method of crosscorrelation analysis of EEG the topical characteristics of statistical connections of the biopotentials of frontal and subparietal association areas and their phase relations and to uncover the frequencies in whose band intercentral relations between association and projection zones in children in ontogenesis are formed mostly.
- 3) To study the functional importance of space-time organization of the biopotentials of projection and association zones in children during the perception of verbal signals at various stages of ontogenesis and to disclose the role of association areas in semantic word evaluation.
- 4) To show the functional importance of the process of spatial synchronization of brain biopotentials in the organization of intercentral interactions at a higher cortical level in children during the perception of commands directed at the activation of concrete sensory or motor systems through a word ("look," "listen," "say," "add").

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PUBLICATIONS

AN ELECTROPHYSICAL INVESTIGATION OF THE DOLPHIN BRAIN

Moscow ELEKTROFIZIOLOGICHESKOYE ISSLEDOVANIYE MOZGA DEL'FINOV in Russian
1978 signed to press 27 Jun 78 pp 2-6, 211-213

[Annotation, introduction and table of contents from book by A. Ya. Supin,
L. M. Mukhametov, et al., Izdatel'stvo "Nauka", 1200 copies, 215]

Annotation

[Text] This book brings together experimental data in the previously un-researched area of the physiology of the brain of Cetaceans, which are of interest in both comparative physiology of the nervous system and in general neurophysiology. These data include information on the unusual location of the sensory areas of the cerebral cortex in dolphins, the unusual way in which electrical reactions (evoked potentials) of the cortex are generated; the unique regulation of waking and sleeping states (the alternating development of sleep in the two cerebral hemispheres); features of the auditory system which are revealed through electrical reactions of the cerebral cortex. Methods used in the eletrophysiological investigation of the dolphin brain are examined.

The book is intended for biologists specializing in neuromorphology and neurophysiology, for zoologists and ecologists.

It has 102 illustrations and a bibliography of 160 titles.

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Introduction

The interest which dolphins have aroused in researchers working in the most varied areas of science is caused by many factors and is, to a significant degree, to be expected. Hardly any other animal which has become available for research, has posed immediately such a number of diverse problems to specialists in various fields. The characteristics of these animals' behavior, which is organized in an extremely complex manner; their striking ability to learn quickly and to enter in contact with man; their developed system of communication by sound; their highly-developed hearing, including the ability to perceive ultra-sound signals; their capacity for active echo location; their brain, which is enormous (for animals); their ability to move about in water at high speeds with a relatively small energy loss and their capacity for prolonged diving--comprise a far-from-complete enumeration of the anatomical and physiological characteristics of dolphins, which deserve the most careful study.

Do dolphins (or Cetaceans in general), in fact, constitute a group of animals which are exceptional in their morphophysiological characteristics and which deserve very special attention on the part of researchers? Hardly. Instead, dolphins provide an instructive example of how expanding the circle of animals which are the objects of detailed morphophysiological study can be unexpectedly important and useful.

Unfortunately, a significant gap exists between the enormous number of animal species which are within the sphere of attention provided by multi-skilled biologists and the number of species which have become model objects for detailed study of their morphological or physiological organization. This limitation on the number of objects for study is, in fact, essential. The continuous intensification of the research requires a thorough knowledge of the object, which is hardly possible with a large number of objects. On the other hand, for purposes of comparing studies, it is advisable for them to be carried out on the same standard objects. Consequently, the selection of a relatively small number of animal species as standard laboratory objects is dictated by the logic of biological studies.

However, this situation also has a reverse side: one cannot always be confident that the data discovered during the course of investigations reflect universal phenomena, and do not just describe the features of the species under study or of the group to which the species belongs. For this reason detailed morphophysiological study of new species may sometimes lead to unexpected results.

And this is precisely what happened when dolphins in captivity became available for detailed study as a result of the opening of oceanaria-dolphinaria in a number of countries. Further, the morphologists and physiologists did not receive simply one more object for study; they received instead an animal which differs radically from the well-known laboratory mammals. During their evolutionary course the Cetaceans

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separated from the main trunk of the evolutionary tree of the mammals and covered an extended developmental path independent of the terrestrial mammals. For this reason it is completely natural that many of the problems of environmental adaptation were solved in a unique way in this branch in the evolution of mammals and that many features of the Cetaceans' morphophysiological organization proved to be unusual for researchers working with terrestrial laboratory animals.

An understanding of the fact that the interest in dolphins is due to their difference from the well-studied laboratory animals rather than to any uniqueness of their position in the animal world reveals the fullest significance of the investigations being carried out on dolphins. They are important primarily because they can save us from a one-sided understanding of a number of aspects of mammalian organization. We need to emphasize especially that the all-around study of an unusual order such as the Cetaceans is definitely of exceptional interest for understanding many questions of mammalian evolution, including the evolution of the brain.

One of the most important and interesting questions in the study of Cetaceans concerns the organization of their nervous systems. The Cetacean brain is one of the largest in the animal world. Although it is difficult to compare the dimensions of the brain in animals with differing body size (neither absolute nor relative brain weight, nor the product of absolute weight multiplied by the relative weight is considered to be a universal criterion for such a comparison), the enormous and complex brain of the dolphins, nonetheless, could not fail to attract to itself the most careful attention from neuromorphologists and neurophysiologists.

However, the study of the brain can be effective only if there is a harmonious combination of morphological and physiological investigations. But the study of the morphology of the Cetacean brain (which is more accessible) has a relatively short history, while until recently there were practically no neurophysiological studies at all.

There are quite definite reasons for the inadequate development of neurophysiological, and primarily electrophysiological, investigations of the Cetacean brain. Despite the fact that dolphins have been held in captivity successfully for many years, they remained until recently were expensive and unavailable animals, the experimental use of which has been extremely limited. Further, many difficulties related directly to experimental methods are encountered in the performance of neurophysiological investigations on dolphins. The characteristics of the the dolphins' structure and physiology make it difficult or impossible to use with them many well-developed methods which are used in working with the usual laboratory animals. Moreover, the methods for working with dolphins must be developed to a significant degree anew, and in so doing there are serious difficulties to be overcome. The difficulties are due to the problem of access to the brain of these animals, the need to take special measures to preserve their lives during operations and experiments, etc. Further, the

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problems of methods are intensified by humanitarian requirements: in working with highly-organized animals, a category which definitely includes dolphins, it is essential to exercise strict control and to limit the traumatic effect of the research methods which are used, while avoiding gross vivisection.

However, the interest in the neurophysiology of the dolphin brain has forced us to look for ways to overcome these difficulties. Attempts have been made repeatedly to carry out physiological investigations of dolphin brains (Langworthy, 1932; Yanagisawa et al., 1966; Lende, Adikman, 1968 and others), although the majority of these attempts have yielded few results or been unsuccessful due to the above-mentioned difficulties with methods. Until recently the literature contained only isolated reports of successful work on the electrophysiological study of the dolphin brain. Among the pioneers of such investigations Bullock and his coauthors (Bullock et al., 1968) should be mentioned first.

The Laboratory of the Evolution of the Sensory Systems of the Institute of the Evolutionary Morphology and Ecology of Animals of the USSR Academy of Sciences, which is represented by the author's collective of this book, is one of the few laboratories which conducts electrophysiological investigations of the dolphin brain. Various aspects of the morphological and physiological organization of dolphin brains have been studied by this laboratory for a number of years. Further, studies of a comprehensive and systematic nature are considered to be one of the main goals of this laboratory.

It goes without saying that certain limitations on the volume of work were nonetheless inevitable. The cerebral cortex, the highest analyzing center, was chosen for more detailed study, although other brain centers were studied along with it. A number of issues requiring first-priority investigation were outlined. They included first of all the problem of the main features of the general morphophysiological organization of the dolphin brain, and mainly of the cerebral cortex. The dolphins' analyzer activity was thought to be the second important problem, with the dolphins' superior auditory analyzer attracting priority attention. And finally, it developed that the regulation of sleeping and waking states--in connection with features of the dolphins' biology and behavior--was deserving of special attention.

In practice, during the process of the investigations all these problems proved to be interrelated to a significant degree and were worked on as a single unit. However, the division of all the results obtained into the indicated areas proved to be convenient for purposes of their systematization, and it formed the basis for the contents of this book.

The major part of the investigations, the results of which form the basis of this collective monograph, were carried out during expeditions to the Black Sea, in the area of Anapa and Novorossiysk, rather than at

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stationary bases or in oceanaria. The authors note with gratitude that it would have been impossible to carry out the research program of the expeditions without the help of a large number of assistants who participated in the labor-consuming auxiliary work. To everyone who assisted with the investigations the authors would like to express sincere gratitude. The authors will also be grateful to their colleagues for any critical comments.

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PUBLICATIONS

HUMAN VOLUNTARY MOVEMENTS SUBJECTED TO ELECTROPHYSIOLOGICAL RESEARCH

Moscow ELEKTROFIZIOLOGICHESKOYE ISSLEDOVANIYE PROIZVOL'NYKH DVIZHENIY U CHELOVEKA (Electrophysiological Research on Voluntary Movements in Man) in Russian 1978 signed to press 12 May 78 pp 2-4, 167-168

[Annotation, Table of Contents, and Introduction from book by M. P. Ivanova, Izdatel'stvo "Nauka", 1550 copies, 168 pages]

[Text] This monograph is devoted to electroencephalographic research on the motor activity of a healthy adult. The author's many years of experimental research and modern domestic and foreign data are generalized. The monograph discusses cortical organization of voluntary movements. The examination of this problem lays emphasis on the Rolandic alpha-rhythm and the motor potential. Part of the monograph is devoted to research on change in the functional state of the cerebral cortex in response to muscle work.

The book is intended for neurophysiologists, psychophysiologists, medical doctors, labor and sports physiologists, and specialists in aerospace biology and medicine.

Thirty-two figures, 5 tables, 30 bibliographic references.

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Introduction

Brain biocurrents have been studied extensively in the last decade in connection with the motor activity of man and animals. The range of issues examined by researchers of this problem is unusually broad. But two directions can be clearly delineated in the numerous studies. Authors of works falling in the first direction approach motor activity as the object of research, and they analyze the EEG to reveal the mechanisms behind movement structure. Authors of works in the second direction interpret motor activity as a factor influencing the functional state of the central nervous system, and especially its higher divisions. The approaches to studying these two aspects differ. Research on the physiological mechanisms behind the structure and organization of different types of movements involves recording EEG's during the time of their performance. The effect of motor activity on the functional level of cortical cells is revealed by recording EEG's before and after physical exercise. Research on the mechanisms behind movement organization is revealing new rhythms associated with these movements both in the total superficial EEG (for example Rolandic alpha-waves and beta-waves) and in the activity of subcortical formations (the hypothalamic theta-rhythm); potentials specific to movements--motor and somatosensory--are described; the activity of neurons in the motor cortex is studied. Thus in this case researchers concentrate their attention mainly on the motor region of the cerebral cortex and on the electric activity it generates. In cases where the researcher is studying the effect of physical exercise on the functional level of the cerebral cortex, as a rule he evaluates fluctuations in the amplitude-frequency characteristics of biopotentials recorded from all brain areas, and especially from the occipital regions, in which the main resting rhythm--alpha-oscillations--is the most highly pronounced. In this case various functional tests are used extensively to reveal the more profound changes arising (opening and closing the eyes, M. N. Livanov's reactivity curves, the rhythm alteration effect in response to flickering light, and so on).

Because the mechanisms of voluntary movements are so tremendously complex and great technical difficulties are encountered in recording the EEG during performance of such movements, this problem is solved as a rule using involuntary motor reactions and elementary voluntary movements as the model. As far as revealing the effect of muscle activity on the functional state of cortical cells is concerned, in this case researchers study changes occurring in the EEG in response to the most diverse athletic activities.

As we know, physical exercise can have a temporary, swiftly passing effect on the state of the body, and it can also elicit long-term consequences expressed as growth or decline in the individual's efficiency and fitness.

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Specialization in one form of motor activity or another can also have an effect on higher divisions of the central nervous system and develop some sort of specific features and properties. One of the objectives of electrophysiologists studying motor activity is to reveal the electrographic signs of all of these effects. In this connection these specialists devote attention to research on the way brain biocurrents change in response to fluctuations in the functional state of the central nervous system's higher divisions in the presence of different physical loads. Special research on animals has the objective of revealing how the pulsating activity of neurons in the motor cortex and biopotentials in the brain's subcortical structures change in response to physical exercise.

In addition to published data, this book presents the results of the author's experimental research conducted in the laboratory of sports physiology of the All-Union Scientific Research Institute of Physical Culture with the active participation of engineers O. I. Ulanov, V. P. Gundarov, and V. V. Kozak and instructor-professors I. P. Ratov, V. G. Lunichkin, V. V. Chernashkin, and A. P. Strizhak. A number of the experiments were performed by graduate students A. A. Shaburyan (Naumova) and Yu. G. Chernykh. The author received considerable and constant consultive assistance during her work from Prof A. B. Kogan, director of the Rostov Institute of Neurocybernetics, and USSR Academy of Sciences Corresponding Member, Prof A. I. Roytbak. To all of these comrades the author extends her deepest and most heartfelt gratefulness.

The author is especially grateful for the constant attention devoted to the work by a dear teacher, USSR Academy of Pedagogical Sciences Academician, Prof A. R. Luriya (deceased).

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PUBLICATIONS

INJURY CAUSED BY COMBINED ACTION OF RADIATION AND TOXINS

Moscow RADIATSIYA I YADY (Radiation and Toxins) in Russian 1977 signed to press 27 Sep 77 pp 2-4, 144

[Annotation, Table of Contents, and Introduction from book by L. A. Tiunov, Ye. A. Zherbin, and B. N. Zherdin, Atomizdat, 2000 copies, 144 pages]

[Text] This book generalizes work done by the authors over a period of several years on the combined action of radiation and toxic compounds, and experience in mathematical modeling of combined injuries. The problem is examined from both the theoretical and the practical aspects.

The possibilities for predicting the effects of combined injuries on the basis of today's ideas about the mechanisms behind the toxic influences of various toxins and of the biological action of ionizing radiation are examined. Detailed information is presented on application of mathematical modeling to this end.

The book is intended for a broad range of radiobiologists and toxicologists as well as workers in associated specialties interested in this problem.

Thirteen figures, 32 tables, 718 bibliographic references.

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Introduction

The problem of the combined action of ionizing radiation and chemical compounds attracted the attention of researchers from the moment radiobiology came into being. In subsequent years it was examined predominantly from the point of view of finding effective resources of radiation protection.

Much less attention was devoted to studying the simultaneous action of radiation and chemical compounds in toxic doses or concentrations. At the same time development of atomic industry, the increasingly greater use of nuclear energy, swift chemicalization of the national economy, and introduction of chemical compounds into practically all spheres of human activity are making the problem of the combined action of radiation and toxins on the body extremely urgent.

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The authors attempted to generalize and systematize their own and published data on this problem. Results obtained in the search for radiation protection resources were used to some extent. Some hypotheses on the mechanism behind modification of radiosensitivity by chemical compounds were found to be useful to analysis of the combined action of radiation and toxins as well. Research on the modifying influence of toxins having different mechanisms of action on the effects of radiation is producing information on the nature of radiosensitivity.

Considering that practically all chemical compounds can be toxins depending on their dose, concentration, means of entry into the body, and exposure time, we limited the span of our work beforehand. Because of the relatively small volume of the monograph, we examined material only on the combined action of radiation and the principal industrial toxins. Interesting chapters of radiobiology devoted to the combined action of ionizing radiation with animal and plant toxins and with bacterial toxins were left out. This issue is only touched upon in part in the section on the combined action of radiation and snake toxins.

The end goal of the work was to answer, on the basis of today's ideas about the mechanisms behind the injurious action of radiation and various toxins, the question as to whether or not it is possible to predict the effects of combined injuries to organisms.

The last chapter, which is devoted to mathematical modeling, examines the general principles of the probability approach to evaluating the injurious action of ionizing radiation and chemical compounds.

Let the reader be the judge of how close we have come to achieving our goal. The authors will gratefully accept all requests and remarks concerning the work.

Chapters I, II, and III are written by L. A. Tiunov, Chapter IV was written by Ye. A. Zherbin, and Chapter V was written by B. N. Zherdin.

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PUBLICATIONS

CIVIL DEFENSE TRAUMATOLOGY HANDBOOK

Moscow RUKOVODSTVO PO TRAVMATOLOGII DLYA MEDITSINSKOY SLUZHBY GRAZHDANSKOY OBORONY (Traumatology Handbook for the Civil Defense Medical Service) in Russian 1978 signed to press 1 Dec 77 pp 2-4, 309-311

[Annotation, table of contents and foreword from book edited by Prof A. I. Kaz'min, Izdatel'stvo "Meditsina", 5800 copies, 311 pages]

[Text] This handbook presents the fundamental principles of modern traumatology in application to the tasks and working conditions of civil defense medical service institutions. Part One devotes its main attention to organizing traumatological care to casualties in major disasters and to their medical sorting at the civil defense medical service's evacuation stages--first aid detachments and specialized hospitals. The problems of preventing and treating traumatic shock and the specific features of its diagnosis in the presence of compound injuries and among elderly and senile persons are discussed in light of modern concepts.

Chapters devoted to wounds and wound infection reflect the premises of prevention and treatment of wound infection in the stage-by-stage treatment system. Special attention is turned in the presentation of the principles of treating thermal injuries to the unique features of care rendered to persons injured by light radiation and burning mixtures. A special chapter deals with the principles of treating and preventing complications arising in the presence of radiation burns.

Part Two of the handbook is devoted to the problems of particular traumatology. The basic premises on the clinical pattern of injuries, the unique features of rendering first aid, on sorting, on premedical and medical care, and on the basic principles of specialized treatment applicable to injuries of the head and neck, the abdomen, the pelvis and pelvic organs, the spine and spinal cord, and the limbs (including major vessels and nerves) are successively presented. Part Three examines the basic concepts on combined injuries--mechanical injuries and burns combined with acute radiation sickness, and injuries and burns contaminated by products of a nuclear burst. A separate chapter deals with the course and principles of treatment applicable to the combination of mechanical traumas and thermal injuries.

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The book is intended for surgeons, traumatologists, stomatologists, neurosurgeons, otolaryngologists, and public health organizers.

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Foreword, by Distinguished Scientist Prof A. I. Kaz'min

World War II ended 50 million human lives. The concluding stage of the war was marked by appearance of nuclear weapons. Atomic bombs dropped by the Americans in 1945 on the Japanese cities of Hiroshima and Nagasaki transformed them into heaps of ruins; the losses suffered by the public totaled hundreds of thousands dead and wounded. Since that time, nuclear weapons have been undergoing continual improvement, their power has risen, and modern missiles carrying nuclear warheads can deliver them to any target on the globe within a short time.

Availability of nuclear weapons to aggressive imperialist states and the possibility for their use in the event of initiation of World War III make preparations for our country's protection a priority task of national importance.

The Soviet Union is persistently fighting to limit arms, to prohibit nuclear weapons, and to maintain peaceful coexistence. At the same time the Communist Party and the USSR government view protecting the socialist fatherland and strengthening the defense capabilities of the USSR and the power of the Soviet Armed Forces as a sacred duty of the party and all Soviet people, as the most important function of the socialist state.

Use of nuclear weapons having tremendous destructive power will mean considerable losses in the population. In this connection Soviet public health and the USSR Civil Defense Medical Service, which is intended to render aid in areas of mass destruction, face a great, complex problem--implementing

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a complex of preventive, therapeutic, and evacuational measures with the goal of providing modern medical care to the stricken public, providing specialized therapy to casualties, and reducing mortality and disability caused by wounds and diseases.

A nuclear strike will be accompanied by concurrent arising of tremendous numbers of wounded individuals, burn victims, and individuals with combined injuries. At the same time the manpower and facilities of the medical service will be extremely limited, and the working conditions will be extremely unfavorable. In this connection much attention must be devoted to the problem of wartime injuries and their treatment, and to organizing traumatological aid to casualties.

Wartime traumatology is not a narrow concept limited to the treatment of injuries to the locomotor-bearing apparatus; instead, it is a broad complex of scientifically grounded theoretical, practical, and organizational premises embracing the problems of pathology, clinical pattern, and treatment of casualties at times of instantaneous arising of massive traumatic injuries.

The goal of this traumatology handbook is to help the civil defense medical service to achieve a certain degree compliance with all of the requirements and features of treating casualties at the evacuation stages of the civil defense medical service. This handbook examines the organization of surgical aid on analogy with corresponding manuals of military field surgery. The difference lies in the fact that treatment is examined only in two evacuation stages: In the first stage, at first medical aid detachments and surviving therapeutic institutions, casualties are rendered first physician's aid; in the second stage casualties receive specialized medical aid in specialized hospitals of a hospital base until a stable outcome of therapy is achieved.

This handbook of military traumatology for the civil defense medical service is being published for the first time on the basis of an analysis of extensive materials, the experience of Soviet medicine in the Great Patriotic War, and the personal experiences of the authors.

The author collective believes that the present work will help improve preparation of medical personnel for work in the civil defense medical service.

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